Development of A Biomedical Imaging Informatics System for Diagnosis and Treatment Planning

Geoffrey Wang[1] and May D. Wang[2]

[1]Computer Science and Chemistry Departments, Georgia Institute of Technology, Atlanta, GA 30332
[2]The Wallace H. Coulter Biomedical Engineering Department, Georgia Institute of Technology and Emory University, Atlanta, GA 30332-0535

Abstract

The medical imaging technologies have been used for detecting tumors through the years. Tumors that can be viewed in imaging are usually big enough to contain billion tumor cells. Some patients may be cured if detected earlier and the surgery is performed well. Those lead to molecular imaging and image-guided surgery research activities, which post new challenges on large scale imaging data management and 3-D visualization. The goal of this project is to develop 3-D imaging informatics system that can interactively navigate large scale of organ and molecular levels imaging data for early diagnosis and treatment planning.

Project description

In this project, we need to integrate the large volume of multi-modality imaging data such as MRI organ imaging data, optical organ imaging data, and molecular imaging data. There are three major components: (1) volume rendering; (2) multi-modality of data integration; and (3) 3-D interactive navigation. We used NIH/NLM Visible Human Project (VHP) data as a baseline model for correlating multi-modality data and for prototyping real-time 3-D interactive visualization.

The 40Gbytes TIFF are tomographical images of human male cadaver. We processed these images to segment the body part from the blue gel surroundings to get ROI (region of interest). Then, we used direct volume rendering to reconstruct 3-D human body. The advantage of using direct volume rendering is the speed. Next, we align the MRI images of the same male to the color textured human anatomy, and use both of them as anchor models. For new patient, only MRI imaging data are available, not the colored anatomy data. Thus, for any surgical planning, we would do two-step of image registration to find map from the patient MRI to VHP MRI model, then through the alignment mapping between VHP MRI and color anatomy, we can deform the VHP color anatomy to get a simulated colored anatomy of the patient. This is not a trivial process. Image registration techniques are used to accomplish this step. The reason is the color human anatomy is closer to what it really looks in real tumor surgical procedures. With the same procedure, the molecular optical imaging can also be mapped to 3-D. Then diagnosis and treatment planning can be proceeded in 3-D with interactive virtual reality tools.

Besides having the multi-modality data aligned and registered, we have also developed a level-of-detail data representation and lossless compression techniques to reduce the amount of data needed for rendering 3-D volume, thus with faster speed. We investigated lossless DCT compression techniques for data reduction. We want to reduce the amount of rendering time to less than human acceptable maximum delay time. This way, the users (e.g., medical surgeons etc.) who interactively utilize this system will see real-time rendering performance. This step is still being tested and improved. With real-time performing rendering, when the users wearing stereo gaggles, they will be able to see 3D "virtual view" of their patients.

Ultimately, the goal is to assist medical professionals in making diagnosis and treatment planning decisions.

Dr. May D. Wang, Biomedical Engineering Department, Georgia Tech and Emory University